AI Companion Robot Data Sharing: Preferences of an Online Cohort and Policy Implications

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Abstract

Policymakers have recognized the urgent need to create AI data protections, yet the interests of older adults have thus far not been well represented. We report peoples' perspectives on small AI companion robots for older adults, along with attendant issues related to facial expression and conversation data collection and sharing. Data are from a cross-sectional survey of an online cohort of the Oregon Center for Aging & Technology at Oregon Health & Science University, with a response rate of 45% and analytic sample of 825 (mean age: 63.9, rang: 25-88). Logistic regressions examined relationships between comfort and data sharing preferences with socio-demographic characteristics. Just over half (52.3%) were somewhat or very comfortable with an artificial companion robot during the pandemic and 45.2% were under normal circumstances.

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In adjusted models, being younger, male, and having lower formal education and greater confidence in computer use were associated with greater likelihood of being comfortable with a companion robot. Those who were at least somewhat comfortable with robots recording their conversations (15%) or reported that they would probably want their facial expressions read for emotion detection (52.8%) also selected with whom they want these data shared. Free text comments were thematically analyzed. Primary themes were that robot-based data collection constitutes over monitoring and invasion of privacy, with participants predicting data privacy, security, and use issues. These findings about the importance potential users place on data protection and transparency demonstrate a need for law and policy to act to enable trustworthy, desirable companion robots.

Keywords: robotics, artificial intelligence, natural language processing, emotion detection, privacy

Intercambio de datos de robots complementarios de IA: preferencias de una cohorte en línea e implicaciones de política

RESUMEN

Los formuladores de políticas han reconocido la necesidad urgente de crear protecciones de datos de IA, pero los intereses de los adultos mayores hasta ahora no han estado bien representados. Informamos las perspectivas de las personas sobre los pequeños robots acompañantes de IA para adultos mayores, junto con los problemas relacionados con la expresión facial y la recopilación y el intercambio de datos de conversación. Los datos provienen de una encuesta transversal de una cohorte en línea del Centro de Oregón para el Envejecimiento y la Tecnología en la Universidad de Salud y Ciencias de Oregón, con una tasa de respuesta del 45 % y una muestra analítica de 825 (edad media: 63,9, rango: 25-88). Las regresiones logísticas examinaron las relaciones entre la comodidad y las preferencias de intercambio de datos con características sociodemográficas. Un poco más de la mitad (52,3 %) se sintió algo o muy cómodo con un robot de compañía artificial durante la pandemia y el 45,2 % se encontraba en circunstancias normales. En modelos ajustados, ser más joven, hombre y tener una educación formal

más baja y una mayor confianza en el uso de la computadora se asociaron con una mayor probabilidad de sentirse cómodo con un robot compañero. Aquellos que se sentían al menos algo cómodos con los robots grabando sus conversaciones (15 %) o informaron que probablemente querrían que se leyeran sus expresiones faciales para la detección de emociones (52,8 %) también seleccionaron con quién querían compartir estos datos. Los comentarios de texto libre se analizaron temáticamente. Los temas principales fueron que la recopilación de datos basada en robots constituye un control excesivo y una invasión de la privacidad, y los participantes predijeron problemas de privacidad, seguridad y uso de datos. Estos hallazgos sobre la importancia que los usuarios potenciales le dan a la protección de datos y la transparencia demuestran la necesidad de que la ley y la política actúen para habilitar robots de compañía deseables y confiables.

Palabras clave: robótica, inteligencia artificial, procesamiento de lenguaje natural, detección de emociones, privacidad

人工智能伴侣机器人数据共享：络群体偏好与政策启示

摘要

政策制定者已经认识到建立人工智能(AI)数据保护这一迫切需求，但迄今为止，老年人的利益尚未得到充分代表。我们报告了人们对为老年人服务的小型AI伴侣机器人的看法，以及随之而来的一系列问题，后者与面部表情、对话数据收集及共享相关。对俄勒冈健康与科学大学的俄勒冈老龄化与技术中心的一个网络群体进行横断面调查并收集数据，调查响应率为45%，分析样本为825人（平均年龄：63.9岁，年龄范围：25-88岁）。逻辑回归分析了舒适度、数据共享偏好与社会人口特征之间的关系。在大流行期间，仅超过一半(52.3%)的人对AI伴侣机器人感到有些舒适或非常舒适，而45.2%的人则对AI伴侣机器人感到不舒适。在调整后的模型中，年轻、男性、正规教育程度较低以及对计算机使用更有信心等因素与“更有可能对伴侣机器人感到舒适”一事相关。那些对机器人记录对话一事至少感到些许舒适的人(15%)或报告称其可能希望读取其面部表情以用于情绪检测的人(52.8%)也选择了其希望与谁共享这些数据。对自由回答的文本评论进行了主题分析。基本主题是，基于机器人的数据收集构成了过度监控和隐私侵犯，并且参与者预测会出

现关于数据隐私、安全和使用的问题。这些关于“潜在用户对数据保护和透明度的重视”的调查结果表明，需要法律和政策采取行动，以创造值得信赖的理想伴侣机器人。

关键词：机器人，人工智能，自然语言处理，情绪检测，隐私

Introduction

The COVID-19 pandemic has heightened awareness of loneliness and social isolation among older adults. The pandemic has also motivated further exploration of acceptance of companion robots (Ghafurian et al., 2021; Samuel, 2020; Shen et al., 2021) with the goal of mitigating loneliness (Berridge et al., 2021; Coghlan et al., 2021; Engelhart, 2021; Jackson, 2019; Jecker, 2021; Portacolone et al., 2020). Implementation has also been jump-started in response to the isolating effects of the pandemic. By 2021, 21 states had moved forward with distribution of small robots to support older adults who may be lonely, some paid for by pandemic relief funding (Engelhart, 2021).

Various forms of telepresence, human-voiced or AI-voiced avatars, and other robots have different ethical implications and may be differently assessed by potential users (Robillard et al., 2020), so it is important to specify the type of companion robot when discussing implications and desirability. This study is focused on non-human artificially intelligent companions that speak using natural language processing. Most of the published research on robots used with older adults features those that do not use natural language processing—those that cannot interact verbally—particularly plush pet-like robots (Sekhon et al., 2022). We report findings from a relatively large U.S. survey on comfort and data sharing preferences for small artificial companion robots and compare responses by various socio-demographic factors. We assess how participants perceive that the pandemic impacts their comfort, and we address the question of whether participants want facial expression and conversation data collected by an artificial companion robot and with whom they want those data shared.

A recent Delphi study with gerontechnology experts in the U.S. and Canada identified predominant potential benefits and risks of using AI robots for this purpose of companionship. The range of reported potential uses included easing loneliness, enabling auto check-ins and the collection of self-report data for assessing health, cognition, and well-being, and the opportunity for a person living with dementia to use their language functions (Berridge et al., 2021). Risks include shaping expectations with misleading marketing

materials that imply that use can "roll back" symptoms of dementia, as well as deception and confusion about who is behind the AI voice—issues frequently raised in the literature (Berridge et al., 2021; Robillard et al., 2020; Wangmo et al., 2019). As reported elsewhere, most of the survey participants reported on in this current paper did not believe that an artificial companion robot would help them feel less lonely if they were feeling lonely and expressed discomfort with the idea of being allowed to believe an AI voice is human should they have dementia (Berridge, Zhou, et al., 2023). As others have discussed, there are significant open efficacy and ethics questions (for example, see Samuel, 2020 and Vallor, 2011) about using robots for care companionship.

Perhaps because the ethical issues are so compelling, data collection through companion robots receives less attention in the literature, though it is also a central issue. In addition to mitigating loneliness, another desired function of companion robots that use AI to interact conversationally is to enable remote monitoring (Berridge et al., 2021; Shen et al., 2021). Environmental data may also be needed for robot navigation, and additional data are likely to be collected by AI companion robots. Artificial companions have monitoring capability with cameras and microphones and there is excitement over the potential capability of detecting cognitive change using predictive linguistic markers (Parsapoor et al., 2023). Privacy violation is possible if the robot records conversations. Users may not be made aware that a robot is recording and possibly sharing these recordings with others (Carver, 2020; Vandemeulebroucke et al., 2018). Further, the inference about emotional states through analysis of facial expressions is anticipated, yet emotion detection is a scientifically and ethically controversial and unregulated practice (Barrett et al., 2019; Crawford, 2021; Stark & Hoey, 2021), leading experts in AI to raise serious concerns over emotion recognition technology and call for its regulation (Crawford, 2021) and prohibition in decision making that impact people's lives and opportunities (Crawford et al., 2019). In 2022, Microsoft stopped using emotion analysis, citing "reliability concerns" and lack of clarity regarding whether "facial expression is a reliable indicator of your internal emotional state" (Hill, 2022).

Studies on data sharing preferences have explored adults' and older adults' perceptions and willingness to share personal and health information through health and wellness information technology (Beach et al., 2009; Kavandi & Jaana, 2020), such as in-home monitoring technology (Boise et al., 2013) and Electronic Health Records (EHR) (Krahe et al., 2019). They found high rates of reported acceptance that health information collected by in-home monitoring technologies be shared with medical doctors or family members (Boise et al., 2013) and low willingness to share their health information with researchers, government agencies, device developers/corporations, or insurance companies (Kim & Choi, 2019). People tend to be more comfortable sharing health data with

third party commercial companies if it is for patient purposes as compared to business purposes (Trinidad et al., 2020). In addition to purpose and recipient of data, there are many other factors that might impact people's willingness to share personal health data, such as personal characteristics (e.g., education, age, gender, race/ethnicity, health conditions), characteristics of the data (e.g., relevance, requirement, amount/extent, accuracy), perceived risks (e.g., privacy concerns), characteristics of the data sharing systems (e.g., transparency of the data sharing systems), and regulations and norms about information sharing (e.g., public health emergency) (Abdelhamid et al., 2017; Beach et al., 2009; Buckley et al., 2011; Frik et al., 2020; Grande et al., 2015; Ivanov et al., 2015; Kim et al., 2017; Krahe et al., 2019; Trinidad et al., 2020). A study comparing adults with mild care impairment (MCI) with those without found no difference in their willingness to share data with doctors or family members; however, most respondents reported privacy concerns, which increased after one year of use (Boise et al., 2013).

The aim of this study is to begin to understand and compare peoples' anticipated comfort with small artificial companion robots and facial expression and conversation data collection and sharing across a range of health and socio-demographic factors. Free text comments offered by survey participants provide nuance and further insight into a range of feelings people express about this use, data collected in the process, and potential sharing of those data. Due to the relatively technologically resourced, online nature of this cohort, the findings are not intended to be generalized to the larger population, but this analysis takes advantage of the fact that this online cohort is well-characterized and thus allows us to ask questions that have not yet been thoroughly studied, such as how might having perceived memory problems or having parents with a history of dementia impact feelings about an artificial companion robot.

Methods

Study Design and Population

The 19-item survey was organized in three sections: Scenarios, Options, and Artificial Companionship. In this paper, we present analyses of the small artificial companionship robot questions about comfort and data preferences (see Appendix A). Responses to questions about perceived potential impact on loneliness and comfort with deception are reported in Berridge, Zhou, et al. (2023). Participants were also asked about their comfort with a companion robot in the form of a larger, human-shaped robot; however, neither of the visual examples used in the survey are currently available on the market, and as such we focus our reporting on findings from questions about the smaller, better-developed robots that are available. The survey was administered using Qualtrics and disseminated by email in June of 2020 to the online survey cohort of the Research via Internet Technology and Experience (RITE) program of the Oregon Center

for Aging & Technology (ORCATECH) at Oregon Health & Science University. This survey is one of quarterly topical surveys these volunteers are asked to complete regarding health, wellness, and technology. The cohort's inclusion criterion was being over the age of 18. The current study used the full sample of 2,434 volunteers registered as active in 2020.

All 2,434 members of the RITE cohort were sent the online survey and 1,082 completed it for a response rate of 45%. As described in further detail in Berridge, Zhou, et al. (2023), respondents were excluded if they were not living in the community (n=2) and if they did not have data for four core variables of interest, gender (missing=72), age (missing=4), education (missing=150), or memory problem history missing=179), leaving a total of 825 included in the analysis. The gender variable recorded as part of the initial intake for the RITE cohort was a limited binary response option of male and female with a write-in option. For this analysis, we coded binary transgender individuals with their reported gender (those who wrote in trans female were coded as women and we coded as men those who wrote in trans male). Because we omitted from our analytic sample the 16% of participants who had missing values for the key variable of interest, reported history of memory problems, we conducted sensitivity analyses that indicated that our assumption that responses to the questions about memory problems are missing at random does not impact our findings.

Dependent Variables

The variables of interest represent the constructs of comfort and acceptability. Two sets of Likert response options were used to measure these [Very Uncomfortable, Somewhat Uncomfortable, Somewhat Comfortable, Very Comfortable] or [Definitely No, Probably No, Probably Yes, and Definitely Yes]. These Likert response options were all labeled to ensure that participants interpret the middle options in the same way.

Participants were asked about their comfort level with small, table-top form artificial companion robots in scenarios of "during normal circumstances" compared with "unusual times when someone cannot come to your home such as during the coronavirus pandemic." Questions assessed comfort and acceptability of facial expression and conversation data sharing. For the subsample of the total participants who reported desire or comfort to have conversations or facial expression data recorded, we further analyzed with whom respondents are willing to share these data [me, my spouse/partner, child(ren), a medical provider, a hired home aide, a technology developer, a health insurance company, no one]. For these seven eight options, entities were adapted from Kim and Choi (2019) and Beach et al. (2009).

Independent Variables

Personal health and demographic information were pre-collected through the RITE cohort surveys. Characteristics that have been shown to be associated

with comfort and preferences for digital technologies and data sharing were included in bivariate analysis and multivariate regression models. These include age (Beach et al., 2009; Ivanov et al., 2015; Kim & Choi, 2019; Thordardottir et al., 2019; Trinidad et al., 2020), gender (Beach et al., 2009; Gell et al., 2015; Kim & Choi, 2019; Lai et al., 2010; Trinidad et al., 2020), formal education (Beach et al., 2009; Gell et al., 2015; Kim & Choi, 2019; Kim et al., 2017; Lai et al., 2010), number of chronic conditions (Abdelhamid et al., 2017; Chappell & Zimmer, 1999; Ivanov et al., 2015; Kim & Choi, 2019; Lai et al., 2010), marital status (Abd-alrazaq et al., 2019; Gell et al., 2015), living status (Lai et al., 2010), confidence of using computer (Czaja et al., 2006), and social support (Baisch et al., 2017), defined for our purposes as level of social activity using the Brief Assessment of Social Engagement scale (0-20) (Morgan et al., 1985). We also included memory problem history in our analytic models (Charness & Boot, 2009), which is a dichotomous yes/no variable for a yes response to one of two questions about 1) presence of self-reported current memory problems or 2) if the participant has been seen by a physician for memory problems. Due to our access to a range of pre-collected data about this cohort, we also chose to examine the unstudied relationships between our outcome variables and presence of a living pet, as well as history of dementia in parents because this might indicate respondents' perceived risk of acquiring dementia (Kessler et al., 2012) and because the perspective gained about dementia may be influential on these questions of interest. There is insufficient variability for analysis by race or ethnicity: 95.9% of respondents were white and 98.5% were non-Hispanic.

Analysis

Descriptive analyses were performed using R software (R Core Team, 2013). The Wilcoxon Signed-rank test (Woolson, 2008) was used to determine whether there are differences between participants' comfort level towards artificial companions under normal circumstances compared with unusual pandemic times. Bivariate and multivariate ordered logistic regression (Bilder & Loughin, 2014) were performed using the R package "MASS" (Ripley, 2011) and "ordinal" (Christensen & Christensen, 2015) to determine whether there were relationships between independent variables and dependent variables that are ordinal (Long & Freese, 2006). We used brant tests (Brant, 1990) based on separately-fitted cut-point equations (Fullerton & Xu, 2012) to test the assumption of proportional odds; the proportional odds assumption is that no input variable has a disproportionate effect on a specific level of the ordinal variable (McNulty, 2021). Only one statistically significant variable in one regression model violated the assumption using a .03 p-value cut-point and is discussed below. This indicates that this analytic choice was appropriate (UCLA: Statistical Consulting Group, n.d.).

Finally, 315 (38%) participants provided optional free text comments upon completion of the survey section on

artificial companion robots. Two members of the research team conducted thematic analysis of these comments to identify themes. They separately developed initial codebooks and met to merge their codes into a single codebook and refine it. Then, they separately coded the comments and reconvened to discuss all discrepancies where codes were differently applied and were able to reach consensus about final coding. The most prominent themes are presented to help understand why participants felt what they reported in the survey questions.

Results

Participants

Table 1 provides the description of the sample in relation to each independent variable. Compared to the general national population, the study sample is older, whiter, and more formally educated. Ninety-five percent of respondents are white. The respondents' ages range from 25 to 88 years with a mean age of 63.93 (SD=13.17). Sixty percent of respondents are 65 or older. The majority (75.6%) have a college degree or more education—far higher than the 32.1% of the U.S. general population. Sixty-five percent of this sample identify as female. Because our sample skews older than the general population, nearly one quarter (24.4%) of our sample report either current memory problems and/or that they have been seen by a physician for memory problems, which is a far greater percentage than the general population.

This sample is also far more technologically experienced and resourced than the general U.S. population. Most of our sample (84.3%) rated their confidence using the computer as high. Ninety-five percent of our respondents report using the computer daily while 81% of the general population reports going online daily (Pew Research Center, 2019b). Our sample also differs dramatically from the general population in their greater access to wireless internet (95% and 73%, respectively) (Pew Research Center, 2019b). Only 73% of the general 65+ population uses the internet (Pew Research Center, 2019b) and 42% do not have wireless broadband at home (Humana Foundation and Oats, 2021). While our sample skews older, among those 65+, 93.3% have wireless internet and 100% use the internet.

Comfort Level with Artificial Companion Robots in Normal and Pandemic Times

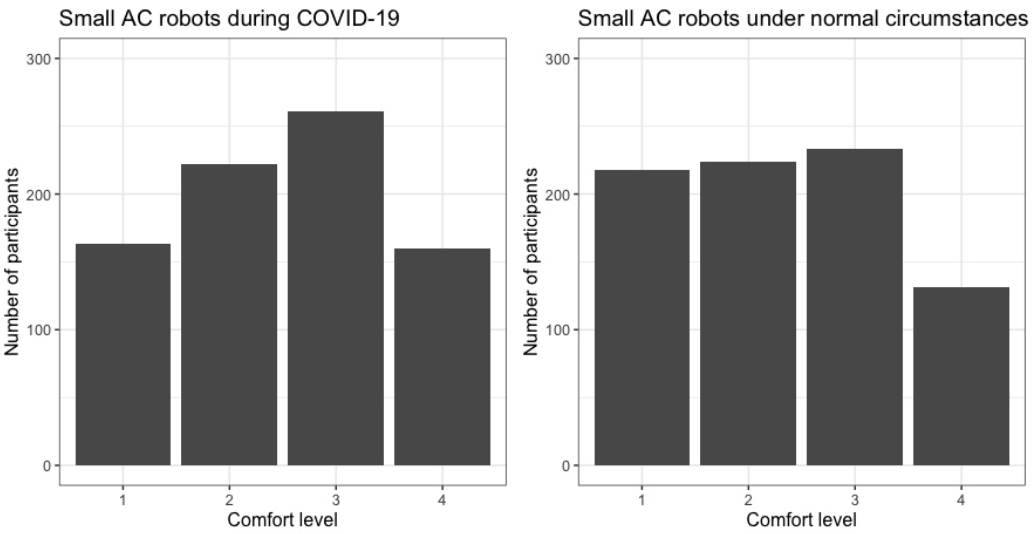
Response frequencies to each question are presented in Table 2 and discussed below. Just over half (52.3%) of the respondents felt somewhat or very comfortable with a small robot artificial companion during unusual pandemic times, and less than half (45.2%) felt that way during normal times. That greater comfort reported for pandemic compared with normal times is significant; however, the effect size is very small.

Table 1. Participant characteristics

Category	Subcategories	Mean/SD/ Frequencies	Percentage
Age (n=825)	Range: 25-88	Mean=63.93 SD=13.17	
Gender (n=825)	Female	534	64.7%
	Male	291	35.3%
Marital status (n=820)	Married/living as if married	577	70.4%
	Not married	243	29.6%
Living status (n=824)	Living alone	162	19.7%
	Living with others	662	80.3%
Education (n=825)	No college degree	202	24.5%
	College degree	276	33.5%
	Master's degree and above	347	42.1%
Memory problem history (n=825)	Memory problem reported	201	24.4%
	No memory problem reported	624	75.6%
Number of chronic conditions (n=790)	3+	540	68.4%
	0-2	250	31.6%
Confidence using computer (n=792)	Highly confident	668	84.3%
	Low-moderately confident	124	15.7 %
History of dementia in parents (n=750)	History of dementia in either of parents	226	30.1%
	No history of dementia in either of parents	524	69.9%
Interaction with pet (n=812)	Often Interact with pet (daily, weekly, monthly)	503	61.9%
	Not often Interact with pet (yearly, rarely, or never)	309	38.1%
Social activity level score (n=800)	Range: 0-17 (out of 20)	Mean:8.47 SD=2.82	

Table 2. Response frequencies: Comfort with small artificial companion robots and data collection

Question	**Very Uncomfortable n (%)**	**Somewhat Uncomfortable n (%)**	**Somewhat Comfortable n (%)**	**Very Comfortable n (%)**
Please think about unusual times when someone cannot come to your home such as during the coronavirus pandemic. In these times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot, like the examples below? (N=806)	163 (20.2%)	222 (27.5%)	261 (32.4%)	160 (19.9%)
In normal times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot? (N=806)	218 (27.0%)	224 (27.8%)	233 (28.9%)	131 (16.3%)
If you had an artificial companion, how comfortable would you be with it recording your conversations? (N=804)	439 (54.6%)	244 (30.3%)	108 (13.4%)	13 (1.6%)
	Definitely No n (%)	**Probably No n (%)**	**Probably Yes n (%)**	**Definitely Yes n (%)**
If you had an artificial companion, would you want it to be able to know how you are feeling by reading your facial expression? (N=806)	175 (21.7%)	206 (25.6%)	347 (43.1%)	78 (9.7%)



Legend: 1: Very uncomfortable, 2: Somewhat uncomfortable, 3: Somewhat comfortable, 4: Very comfortable.

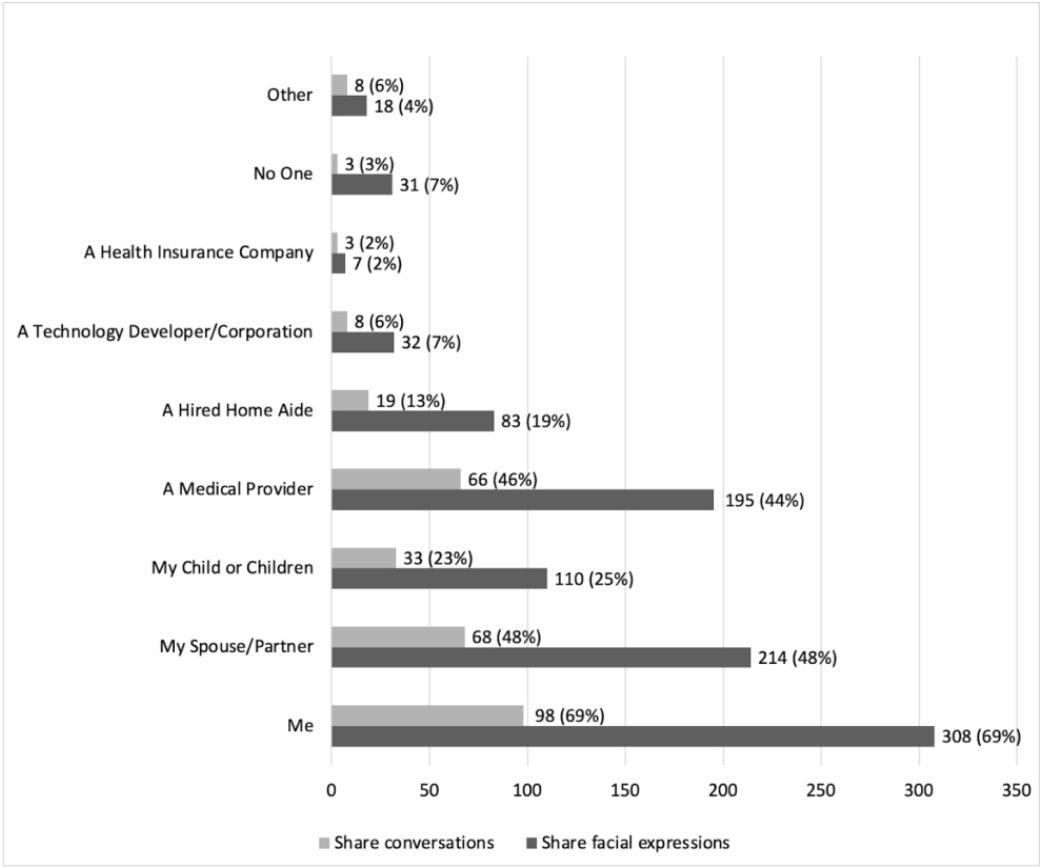
Fig.1. Comfort with small artificial companion robots in normal and pandemic times

Conversation and Facial Expression Data Sharing Preferences

As depicted in Table 2, about half (52.8%) of the participants reported that they either probably or definitely would want their facial expressions to be read by an artificial companion to infer their feelings, while a minority (15%) were at least somewhat comfortable with artificial companions recording their conversations. Those who responded "Somewhat Comfortable" or "Very Comfortable" with recording conversations and those who "Probably" or "Definitely" would want an artificial companion to read their facial expressions were asked with whom they wanted that information about them shared. Figure 2 illustrates with whom participants who were somewhat or very comfortable with having these data collected would like those data shared. Those who were not amenable to having facial expressions (47.3%) or conversations (84.9%) recorded were not asked with whom they'd want those data shared. Among those asked, the most common entity participants wanted both conversation and facial expression data to be shared with is "me" (98/142; 69% and 308/444; 69.4%, respectively), followed by my spouse/partner (68; 47.9% and 214; 48.2%) and a medical provider (66; 46.5% and 195; 43.9%). Far fewer—about one in four—would like to share conversation data (23.2%; 33) and facial expression data (24.8%; 110) with their child/children.

Less than 20% would like to share their conversation data (19) or facial expression data (83) with hired home aides. Less than 10% want data

shared with technology developers (8 and 32). Only two percent wanted conversation data (3) or facial expression data (7) shared with a health insurance company. Three percent (3) wanted conversation data and 7% (31) wanted facial expression data shared with no one. Categories written in as "other" by at least two participants each were a close friend, pastor/priest, and my power of attorney.



Note: Those who reported that they were somewhat or very uncomfortable with these data capture capacities were not asked these questions about entities with whom they'd want these data shared. Percentages are of the two subsamples who reported somewhat comfortable or very comfortable with an artificial companion robot collecting emotive data (n=444), and of those who were somewhat or very comfortable with collecting conversation data (n=142).

Fig. 2. Entity with whom conversation and facial expression data could be shared among those responding somewhat comfortable or very comfortable with these data being captured

Multivariate Analysis for Comfort with Artificial Companion Robots and Data Sharing

In multivariate adjusted analyses, the characteristics that are significantly associated with comfort with artificial companion robots and the two data sharing preferences are age, gender, confidence using computers, and education. No significant differences were detected between those reporting a memory problem history and those without. Greater age is negatively associated with comfort with small artificial companion robots under normal circumstances (odds ratio [OR]=0.99; 95% confidence interval [CI]= [0.97, 1.00], p=0.022) and during pandemic times (OR=0.99; [0.97, 1.00], p=0.045), and comfort with an artificial companion robot reading facial expression (OR=0.99; [0.97, 1.00], p=0.041). This means, for example, that with each one year of additional age, people have a 1% lower likelihood of being comfortable at any level of comfort with small artificial companion robots; that is, lower likelihood of reporting report very comfortable versus somewhat comfortable, somewhat comfortable versus somewhat uncomfortable, and somewhat uncomfortable versus very uncomfortable. For example, compared to a 62-year-old, a 63-year-old has a 1% greater likelihood of reporting feeling somewhat uncomfortable versus somewhat comfortable, and this difference continues to increase by 1% with each year of age.

Participants who identified as female were 28% more likely than were males to report one level of lower comfort with small artificial companion robots in normal times (OR=0.72; [0.53, 0.97], p=0.029). Females were also 34% more likely to feel uncomfortable with artificial companion robots recording their facial expressions (OR=0.66; [0.48, 0.90], p=0.008) and 39% more likely to not want conversations recorded (OR=0.61; [0.44,0.84], p=0.002). Having the highest level of education (master's degree) was associated with a 33% greater likelihood of reporting one lower level of comfort with small artificial companion robots in normal times (OR=0.67; [0.46, 0.96], p=0.030).

Participants who reported high confidence using computers were 68% more likely than those reporting low-moderate confidence to feel comfortable with small artificial companion robots during normal times (OR=1.68; [1.15, 2.47], p=0.007) and 80% more likely during pandemic times (OR=1.80; [1.23, 2.65], p=0.003). They were also 87% more likely to report one level greater comfortable with facial expression (OR=1.87; [1.27, 2.77], p=0.002) and 78% more likely for conversation data collection (OR=1.78; [1.16, 2.77], p=0.009).

Also in adjusted models, being married (OR=0.50; [0.31, 0.83], p=0.007) and living alone (OR=0.51; [0.28, 0.92], p=0.025) were associated with 50% and 51% lower comfort with artificial companion robots recording conversations, respectively. In the model for comfort with artificial companion robots recording conversations, the variable for marital status violates the

Table 3. Statistically significant variables for bivariate and multivariate ordinal logistic regression

Predictors	Small artificial companion robots during pandemic	Small artificial companion robots during normal times	Comfort with artificial companion robots reading facial expression	Comfort with artificial companion robots recording conversation
Predictors based on bivariate ordinal logistic regression	Age: 0.98 (0.98-0.99) **	Age: 0.98 (0.97-0.99) ***	Age: 0.98 (0.97-0.99) ***	Female: 0.64 (0.48-0.84) **
	Highly confident about using computer [a]: 1.84 (1.30-2.61) ***	College degree [b]: 0.71 (0.51-0.99) *	Memory problem reported: 1.36 (1.01-1.83) *	Highly confident about using computer: 1.62 (1.10-2.41) *
		Master's degree or above [b]: 0.61 (0.45-0.84) **	3+ chronic conditions: 0.64 (0.48-0.84) **	
		Highly confident about using computer: 1.73(1.23-2.45) **	Highly confident about using computer: 1.98 (1.39-2.83) ***	
			History of dementia in either of parents: 0.73 (0.55-0.98) *	
Predictors based on multivariate ordinal logistic regression	Age: 0.99 (0.97-1.00) *	Age: 0.99 (0.97-1.00) *	Age: 0.99 (0.97-1.00) *	Female: 0.61 (0.44-0.84) **
	Highly confident about using computer: 1.80 (1.23-2.65) **	Female: 0.72 (0.53-0.97) *	Female: 0.66 (0.48-0.90) **	Married/living as if married: 0.50 (0.31-0.83) **
		Master's degree or above: 0.67 (0.46-0.96) *	Highly confident about using computer: 1.87 (1.27-2.77) **	Living alone: 0.51 (0.28-0.92) *
		Highly confident about using computer: 1.68 (1.15-2.47) **		Highly confident about using computer: 1.78 (1.16-2.77) **

Note:

a. Reference group: Low-moderate confidence of using computers.

b. Reference group: No college degree.

c. Reference group: have 0-2 chronic conditions.

*p<0.05; **p<0.01; ***p<0.001

proportional odds assumption based on a brant test result of p=0.01. We relaxed this assumption using a generalized ordinal logistic regression model and found ORs of 1|2: OR=0.54; [0.32-0.90], p=0.002; 2|3: OR=0.41; [0.23-0.82], p=0.002; 3|4: OR: 1.29, [0.27-6.13], p=0.753.

Free-text Comments

At the conclusion of the survey section on artificial companion robots, a prompt was given to ask for written comments that participants would like to share. While our survey questions did not probe as to the reasons people had for indicating their comfort levels with artificial companion robots, these written responses provide some helpful insights.

The most raised issue was that of the invasion of privacy and perception that artificial companion robot-based data collection is excessive monitoring. The related issues of data security, third party use, or exploitation of data were also specifically noted by numerous participants. For example, a participant explained, "Overall I like the idea of an AI companion or device to check-in on a family member. Particularly to alert medical services and family if an emergency arises. However, I have concerns about how that data is being stored and used by third party companies. Far too often that data is not being stored securely and being sold to third party companies for data aggregation." Another wrote, "My mood is not a piece of data like my temperature or blood pressure. Yet, people tend to accept as information things which are stated with authority. There is huge opportunity for intrusion into privacy and for action taken in reliance on mechanical intelligence against the wishes of the patient." Interestingly, all six participants who self-identified as current or former tech industry workers expressed aversion and strong concerns about data security and privacy. Some participants noted that artificial companion robots' appeal would be contingent on their ability to maintain control over it, adjust it, and enable privacy when wanted. Other common sentiments were a preference for a robot to complete physical tasks rather than provide companionship, and many specified that use of artificial companion robots should not be a substitute for human contact in elder care.

Discussion

Like previous studies that have found less interest among older than younger adults in digital technologies like sensors and wearables (Thordardottir et al., 2019), greater age in this survey was associated with lower comfort with small artificial companion robots. Lower comfort among female compared with male participants and greater comfort with higher computer confidence are also consistent with the literature on other forms of data-intensive technologies with regard to gender (Gell et al., 2015; Lai et al., 2010) and computer self-efficacy (Czaja et al., 2006; Kavandi & Jaana, 2020). In contrast to numerous findings that greater education is associated with higher receptivity to technologies like telecare

and electronic health records (Abd-alrazaq et al., 2019; Chappell & Zimmer, 1999; Gell et al., 2015; Lai et al., 2010), those with a master's degree or more education were the least comfortable with artificial companion robots during normal times. Greater education may be associated with greater financial resources to access alternatives to companion robots, such as hired support in the home. Another possible but untested interpretation of this finding is that if formal education is also associated with awareness of a lax data security environment outside of the healthcare system, people with graduate degrees may be more likely to have knowledge that would give them pause regarding personal comfort with robots. Misconceptions about data use are widespread among the U.S. public (Turow et al., 2015). A question for future work is whether formal education serves as a buffer against misconception or resignation to privacy or security risks.

Our finding of statistically significantly greater comfort with a robot during pandemic times when in-person human interaction is limited indicate that new forms of engagement are desired during a pandemic. Artificial companion robots may not be viewed as acceptable substitutes for in-person human interaction except by some in situations such as a pandemic. This cross-sectional survey of perceived comfort could not assess actual sustained or temporary fluctuations in adoption and use.

Facial Expression and Conversation Data Preferences

The wording of the data collection questions was chosen to optimize clarity around complex devices and to reflect realistic decision-making scenarios. Audio collection, we presumed, would be more likely to be recommended by a care provider; hence the more passive question about "comfort with" for that type of data. Comfort with an artificial companion robot recording conversations was very low. We would expect the low comfort ratings for conversation data to be even lower had we worded the question in relation to desirability, as we did with the facial expression data question. The different questions we used limits our ability to directly compare preferences between the two types of data.

About half of the respondents were interested in the possible collection of facial expression data, which suggests interest in enhanced interaction capabilities with an artificial companion robot. It is important to note that this initial survey question did not elaborate on the use of data beyond inferred emotional states or suggest that these data would be shared with anyone in particular or for a specific use apart from the robot "knowing how you are feeling." In light of ethical debate regarding uses of these data for nudging and influencing behavior, we acknowledge that our line of questioning was limited. Martin and Nissenbaum (2016) have shown that responses to questions about preference for data sharing tend to fail to match peoples' actual sharing

behaviors because contextual variables matter, such as the specific entity with whom data are shared or the purpose. Our findings of differences between entities with whom respondents want their data shared—discussed below—support this observation that information flow matters (Martin & Nissenbaum, 2016). Future research should also assess how different framings, parameters, and presented uses of such data may impact desirability. For example, in their work on dishonest anthropomorphism, Selinger and Leong (2019) raise a specific question of relevance to this inquiry: "To what extent should a robot be permitted to "read" facial expression, and then act/react based upon its analysis? For example, if a robot decides its user is relaxed or receptive to the current exchange, should it be allowed to make different recommendations than if it perceives tension or anxiety?" (Seling & Leong, 2019, p. 305). Previous research has highlighted concerns held by some older adults about threats to their autonomy with ElliQ—a voice assistant robot that uses a human-sounding voice. The suggestions and reminders ElliQ offered were interpreted as interfering in autonomous decision making and concerns were raised about paternalistic coercion (Coghlan et al., 2021). Future research should provide such details to study participants regarding use scenarios.

Male gender and higher confidence using the computer were the strongest predictors in adjusted analysis of preferences for conversation or facial expression data sharing, and greater age was associated with lower comfort with facial expression data collection. An implication of these findings in demographic context is that if both being older and female are associated with lower comfort with collection of emotive data, it may be worth rethinking targeting older adults as a very early adopter population for artificial companion robots with this capability. At the very least, it may require that opportunities not to engage with these forms of data collection in artificial companion robots be taken seriously as an issue of equity based on potentially differential impact or concerns by age and gender (Berridge & Grigorovich, 2022).

Our findings of no difference in adjusted models between people reporting memory problems and those who did not suggests that this is not a predictive factor as might be expected given the focus on use of other forms of robots (i.e., pet-like) in dementia care. A possible but untested explanation is that perceived vulnerability and desire for monitoring may be counteracted by increased sensitivity to life intrusions, given the threats and eventual reductions in one's autonomy that dementia causes. There may exist a tension between recognition of one's vulnerability with symptoms of memory problems and the expectation that this makes one vulnerable also to reduced autonomy, paternalism, or challenge one's self-concept (McNeill et al., 2017). One study of technology engagement by people living with dementia found that desire to use AI to assist with self-management was contingent on their ability to have total control over the technology, and with awareness of

their greater vulnerability to being controlled by rather than controlling AI devices, some decided not to use them at all (Dixon et al., 2021). Other qualitative research has found perception of threat to dignity when a robot appears toy-like or designed for children, which may be the case for one of our two small robot examples (Coghlan et al., 2021). That research also revealed perceptions among some older adults that robots that have human voices and emulate human companionship are patronizing, demeaning, or condescending (Coghlan et al., 2021). It is possible that for these reasons, new forms of monitoring or cartoon-like companion robots may be less appealing to those concerned about their memory than one might expect given their purported benefit for people living with dementia. These concerns may in effect cancel out potential greater appeal for people experiencing memory issues. These are important questions for future research.

Data Sharing Preferences

Findings regarding with whom participants wanted to share each type of data are consistent with previous research about people's relative willingness to share personal and health information with a spouse or partner (Ivanov et al., 2015) and medical provider (Beach et al., 2009; Boise et al., 2013; Kim & Choi, 2019). The finding that a number of participants who were at least somewhat comfortable with this data collection wanted to access those data themselves suggests the potential interest in this approach for participants to learn from, assess accuracy, or use these data to manage their emotional or cognitive health and well-being.

It is interesting that thirty-one of the participants who wanted a robot that could read their facial expressions wanted inferred feelings from these data shared with no one because it is extremely unlikely that data would be collected but not reported to or accessed by anyone. This finding reflects option preferences among potential consumers that are unaligned with prevalent data practices.

This finding may also be indicative of the need for an emphasis on clear communication and consumer education about what happens with their data, particularly given how few participants endorsed sharing with tech developers or health insurance companies. It is clear that sharing of conversation and facial expression data with these two entities is not desirable, yet problems of data sharing and security abound in adjacent technologies such as smart home devices and voice-assistants. In fact, most health apps focused on dementia lack a privacy policy and admit to possible data sharing with outside parties (Rosenfeld et al., 2017). Research has highlighted barriers to adoption by older adults of potentially useful technologies when preferences about information sharing are not accounted for (Frik et al., 2023). Another consideration that others have noted is that in general, older adults may be less familiar than are younger adults with devices that enable constant surveillance, which could negatively impact their privacy (Carver, 2020). Consumer education

and evidence-based personalized tools to assist or walk-through the adoption value and risks of AI companion robots could help people and families discuss the nuances of acceptance, conditional acceptance, or rejection of such tools (Berridge, Turner et al., 2023).

Policy and Regulation

The outstanding ethical, regulatory, and policy questions that require attention for appropriate AI robotics use for companionship are many and complex. Where artificial companion robot function depends on the collection of data, there is an inevitable tension between necessary functionalities and control over what else happens with that data, particularly absent AI regulation, data privacy law, and transparency in the United States. Older adults' interests are thus far not well represented in the larger AI and data privacy policy discourse (Stypińska, 2021; WHO, 2022). It is critical that these interests be surfaced and represented given the diverse values, demand for data, its commercialization, and the range of harms that have been identified among other marginalized communities (Green, 2021; Greene et al., 2019; Hoffmann, 2019; Miceli et al., 2022). Optional comments offered by 38% of our participants provide some additional insight into concerns about artificial companion robots that are largely consistent with those expressed by gerontechnologists and geriatric care professionals (Berridge et al., 2021; Wangmo et al., 2019). They emphasized the need for human interaction and patient authority over their own experiences ("My mood is not a piece of data like my temperature or blood pressure"), with many describing privacy and data security threats. These findings suggest the critical need for data use transparency policy and enforcement. Under the Health Insurance Portability and Accountability Act (HIPAA) regulations, device companies are not considered covered entities, despite the use of health information (Ho, 2023). Despite use of direct-to-consumer device data for commercial purposes, there is no requirement that developers provide privacy policy statements in the U.S., let alone make them widely comprehendible (Ho, 2023; Lupton & Jutel, 2015). Data sharing practices matter to people but are inadequately communicated to them (Lupton & Jutel, 2015).

In a recent survey, the majority of 65+-year-olds, including those with MCI, felt that "it is critical to have new privacy regulations on Voice Assistant Systems [e.g., Amazon Alexa, Google Assistant] data in place" (Spangler et al., 2022). This may be particularly important where consumer technologies have health implications, such as early detection of cognitive change proposed through conversation data. Misuse or inappropriate access of such economically valuable, sensitive data about people have serious potential implications for important aspects of their lives, such as employment. These kinds of data vulnerabilities to AI harms should put companion robots and other consumer home care technologies for older adults on the map for policy makers with the power to regulate commercial surveillance and data security.

Participants' concerns over what happens with their data and their low comfort sharing it with certain entities further support the call for broader stakeholder engagement in AI policy making (Green, 2021; Ho, 2023; Stark & Hoey, 2021). Policy making that is informed by democratic, inclusive deliberation is an appropriate level to begin to address security and privacy concerns over artificial companion robot use and data sharing. The U.S. has no equivalent to the European Union's General Data Protection Regulation (GDPR) and its regulation is lax. The perception that policy cannot keep pace with technology like AI robots can lead to a counterproductive fatalism, but in addition to limited state movement (the California Consumer Privacy Act in addition to other state laws), there is expectation that the U.S. will soon have federal AI privacy regulation. Recent proactive policy moves in the U.S. signal that protections for people can be prioritized. The new Blueprint for an AI Bill of Rights produced by the Office of Science and Technology Policy and published by the Biden Administration sets forth, for the first time, principles to guide protections for people (Hendrix, 2022). It includes "a set of five principles and associated practices to help guide the design, use, and deployment of automated systems to protect the rights of the American public in the age of artificial intelligence" (The White House, 2022). These five principles promote systems that are safe and effective; that protect us from algorithmic discrimination; that protect our data privacy, that allow insight into when and how they are being used; and that offer viable alternatives for opting out of their use. For example, the Data Privacy principle is that "You should be protected from abusive data practices via built-in protections and you should have agency over how data about you is used." (The White House, 2022). Of direct relevance to consumer technologies for older adults, the Federal Trade Commission recently sought comments on a proposed rulemaking related to commercial surveillance and data security. This survey's findings suggest that engagement of gerontologists is needed in these broader conversations about disparate impacts, harms, and vulnerabilities to draw attention to the unmet privacy, transparency, and data security expectations of older consumers (University of Washington Privacy and Security Researchers, 2022).

Viral adoption of large language models (i.e., ChatGPT) on the heels of growth in use of machine learning has further spotlighted need for AI regulation in the U.S. to protect data and privacy. White House science office leaders have called for public participation and action by lawmakers and policy makers, noting that "In this window of public intrigue, anxiety, and scrutiny, there is an unprecedented opportunity for political engagement" (Nelson, 2023, para 10). AI, it is noted, is no longer an abstraction. Meaningful regulation of consumer products used at home should be a priority within gerontology and professional and advocacy organizations such as the Gerontological Society of America and AARP, as older adults are often the focus of new forms

of data collection. Organizations that are already vocal advocates for privacy, data security and regulation, and addressing AI harms could direct far more attention to the interests of older adults and the age tech industry, which has largely been out of focus (Stypińska, 2021). This study's findings and others suggest that these are important priorities for older adults.

Limitations

This study has several limitations. The survey respondents are not representative of the general population regarding racial diversity or technological or formal education experience (for greater detail see Berridge, Zhou et al., 2023). Future work needs to emphasize examining these issues in more racially diverse and resource-diverse populations, as well as among older adults living with diagnoses of MCI or Alzheimer's disease or related dementias. Having relied on pre-collected gender data and having not oversampled non-binary or transgender participants, our analysis of gender differences is exclusionary as it is limited to comparisons between those who identify as male or female, including trans men and women. For this analysis, we coded transgender individuals with their reported gender when that was written in (those who wrote in trans female were coded as female and we coded as male those who wrote in trans male). Research is needed that oversamples people with diverse non-binary gender identities to reach adequate sample size for comparative quantitative analysis. The wording of the questions was chosen to optimize clarity around complex devices. This may have introduced enough variability between the questions about data collection to render incomparable. Further, in accordance with COVID-appropriate protocols, we did not provide participants with devices to allow them to physically interact, which makes attitude assessment towards them challenging. Studies of implementation of AI-based robots over time are needed to understand actual impact, perception, and experiences (Berridge, 2017; Pols, 2012).

Conclusion

Roughly half of our relatively tech savvy participants thought they would be at least somewhat comfortable using an artificial companion robot at home, but often cited preference for it to complete tasks for them and cautioned against reduction of human contact in elder care. In adjusted models, factors associated with greater likelihood of reporting greater comfort were being male, younger, with lower formal education, but with greater confidence in computer use. There was moderate interest in having a robot use facial expression data and very low comfort with conversation data collection, which raises questions that need to be resolved before widespread implementation due to the high likelihood of audio recording by artificial companion robots and possibility that older adults may not be given opportunities for informed consent in practice (Berridge, 2018; Berridge & Wetle, 2020). Desire to share these data also differed across age, gender, and other factors. As a group,

sharing with technology developers or health insurance companies was not desired, while nearly half of those who reported comfort or desire for such data collection wanted it shared with a medical provider and spouse/partner, with the highest number wanting to access these data themselves.

Specific concerns expressed by gerontologists and researchers in fields engaging ethical AI were shared by this online cohort of potential consumers. Participants predicted privacy, security, and data use issues that are not addressed by the weak regulatory landscape in the U.S. (Ho, 2023; Portacolone et al., 2020). Addressing the concerns raised by study participants and enabling protections and transparency to are likely to promote trust in data practices (Frik et al., 2023) and thus contribute to the appeal of companion robots. Concerns expressed by study participants and lower comfort with greater age and among female-identified participants indicate that policies and regulations should be informed by the needs of older women who represent the majority of older adults, particularly in higher age groups where adoption of companion robots is often targeted. These findings support the observation that processes that meaningfully engage older adults to inform practice and policy are overdue (Robillard et al., 2019; Sekhon et al., 2022). Companion robots, which are designed to be animated and appealing, are also poised to extend digital surveillance and analysis into the home. Data collection through artificial companion robots is primed to be wide-ranging and includes practices on which there is no scientific or ethical consensus (Stark & Hoey, 2021). It is important that what guides practice is older adult-engaged research, design that is responsive to that research, and policy to protect the rights and interests of older adult users.

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Conflicts of Interest/Competing Interests

The authors have no conflicts or competing interests to disclose.

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Appendix A

Online Resource 1: Survey introduction and questions on artificial companion robots

Intro

Technology for In-Home Care: These questions ask you about some new technologies used in home care. The questionnaire should take no more than 10 minutes of your time. We are interested in the opinions of people of all ages, regardless of your experience or lack of experience with care. Some of the questions will ask you to think of your primary support person. Your "primary support person" is someone who would be most likely to step in if you needed care or help. We know you may not have a primary support person now but please think about it in terms of your family member or friend who would care for and look out for you.

Start of Block: AI Companionship

Q9 Interest is growing in artificial intelligence that is built into robots. Robots can be made to look like animals or humans. One use for these robots is to provide companionship because these robots can hold conversations with people. Please answer the following questions about your comfort with this kind of technology.

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q9_a Please think about unusual times when someone cannot come to your home such as during the coronavirus pandemic. In these times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot, like the examples below? [two images of products GenieConnect and ElliQ were presented]

- ○ Very Uncomfortable
- ○ Somewhat Uncomfortable
- ○ Somewhat Comfortable
- ○ Very Comfortable

q9_b Now please imagine that we are again living under normal circumstances so that you are able to spend time in person with other people.

In normal times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot?

- ○ Very Uncomfortable
- ○ Somewhat Uncomfortable
- ○ Somewhat Comfortable
- ○ Very Comfortable

q12 Robotic technology is getting more advanced. For example, robots are now able to read your facial expression and know what emotion you're expressing.

If you had an artificial companion, would you want it to be able to know how you are feeling by reading your facial expression?

- ○ Definitely No
- ○ Probably No
- ○ Probably Yes
- ○ Definitely Yes

Display This Question:

If q12 = 3

Or q12 = 4

q12_b If an artificial companion could read your facial expressions, who would you want it to share this information about your feelings with? (Check all that apply)

- [ ] Me
- [ ] My spouse/significant other/partner
- [ ] My child or children
- [ ] A medical provider (hospital, nurse, or doctor)
- [ ] A hired home aide
- [ ] A technology developer/corporation
- [ ] A health insurance company
- [ ] No one - I wouldn't want my facial expressions to be recorded
- [ ] Other (please describe) _____

q13 If you had an artificial companion, how comfortable would you be with it recording your conversations?

- ○ Very Uncomfortable
- ○ Somewhat Uncomfortable
- ○ Somewhat Comfortable
- ○ Very Comfortable

Display This Question:

If q13 = 3

Or q13 = 4

q13_b If you had an artificial companion that recorded your conversations, who would you want it to share those with? (Check all that apply)

- [ ] Me
- [ ] My spouse/significant other/partner
- [ ] My child or children
- [ ] A medical provider (hospital, nurse, or doctor)
- [ ] A hired home aide
- [ ] A technology developer/corporation
- [ ] A health insurance company
- [ ] No on - I wouldn't want my conversations to be recorded
- [ ] Other (please describe) _____

q15. Do you have any comments you'd like to share?

(Open box write-in response)